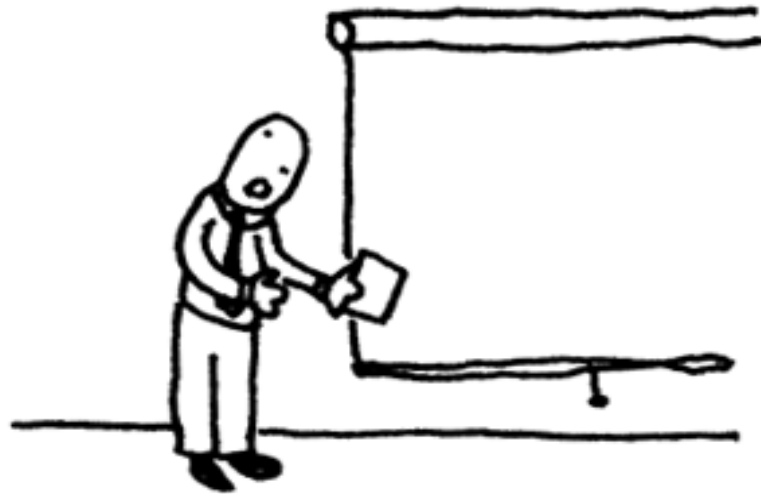


Anesthetic Implications of Malnutrition

CPT John Zaugg
MD



and now, let's dim the
lights, so i can show
you computer slides and
read the exact text of
the slides to you

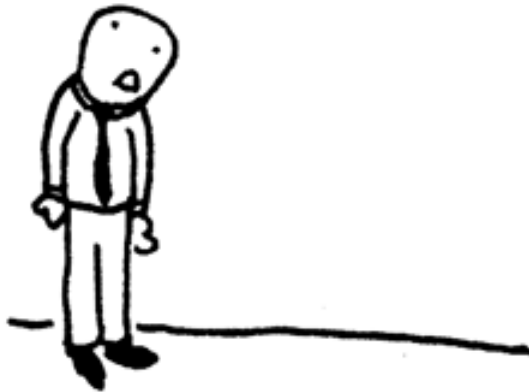
Why is he doing this?

- (Tell touchy-feely story)
- What does the future hold?

Objectives

- **1. Discuss various common types of malnutrition/vitamin deficiencies.**
- **2. Discuss how this lack of nutrition may effect a patient's anesthesia.**
- **3. Discuss how malnutrition should be managed peri-operatively.**

History of malnutrition



THIS DAY IN HISTORY:

on this day in 1884, the color beige was invented, and marked the first time that a color had been specifically designed to crush a man's soul

General malnutrition info

- 16.9% of women and 11.4% of men
- 15-26% of hospitalized elderly
- Surgery → Increased mortality, morbidity, and length of stay

“Big Picture” complications

- Increased susceptibility to infection
- Poor wound healing
- Increase incidence of decubitus ulcers
- Overgrowth of bacteria in the GI tract
- Abnormal nutrient loss in stool

Assessing Malnutrition

- History
- Physical Exam
- Lab Exam: Albumen (<2.2 =severe), electrolytes, certain vitamins/minerals.
- EKG

Perioperative Management of Malnutrition - General Principles

- Ensure any nutrition deficiencies are corrected before elective cases.

Nutrition Deficiencies

- Protein-Energy Malnutrition
- Fat-soluble vitamins
- Water-soluble vitamins
- Mineral and trace element deficiencies

JCAHO Tip of the week:



FUN FACT:
if you had just washed
your hands more, your
parents wouldn't have
gotten a divorce

Protein-Energy Malnutrition

- Marasmus – Severe energy depletion (protein, carbohydrate and fat).
 - Wasting of muscle mass and depletion of body fat stores.
- Kwashiorkor – Inadequate protein intake despite good energy intake.
 - Marked muscle atrophy with normal or increased body fat.

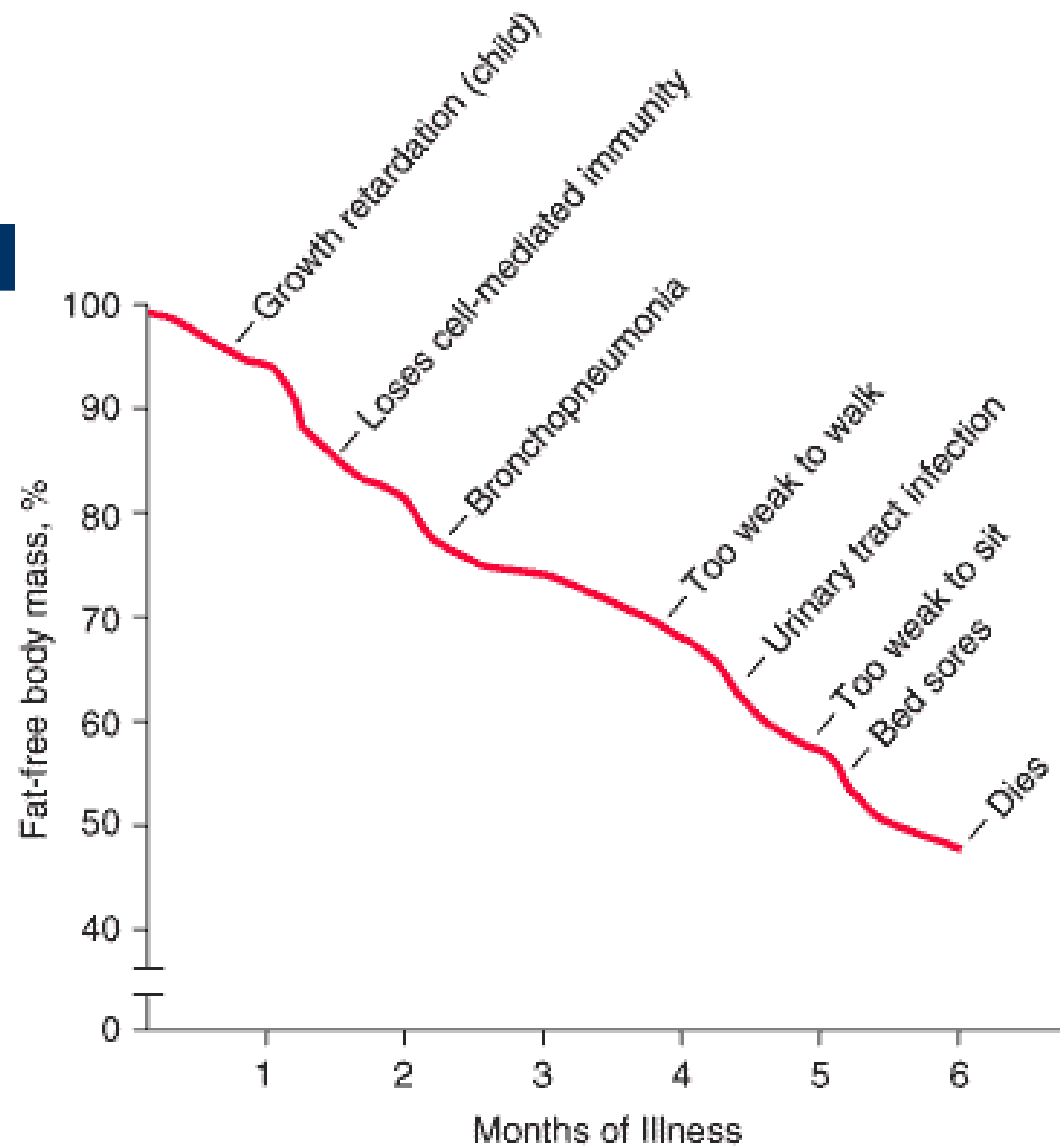
Marasmus vs Kwashiorkor

- Marasmus

- Diminished height/weight
- Emaciated/weak
- Brady, HoTN, Hypotherm
- Thin, dry skin
- Redundant skin folds
- Thin, sparse hair
- Severe constipation
- Ravenously hungry

- Kwashiorkor

- Normal weight/height
- Anasarca
- Rounded cheeks
- Pursed mouth
- Pitting edema
- Dry, atrophic, peeling skin
- Dry, dull, colorless hair
- Hepatomegaly
- Distended abdomen



Marasmus vs Kwashiorkor



Marasmus



Fat-soluable vitamins

- Vitamin A
- Vitamin D
- Vitamin E
- Vitamin K

Water-soluble vitamins

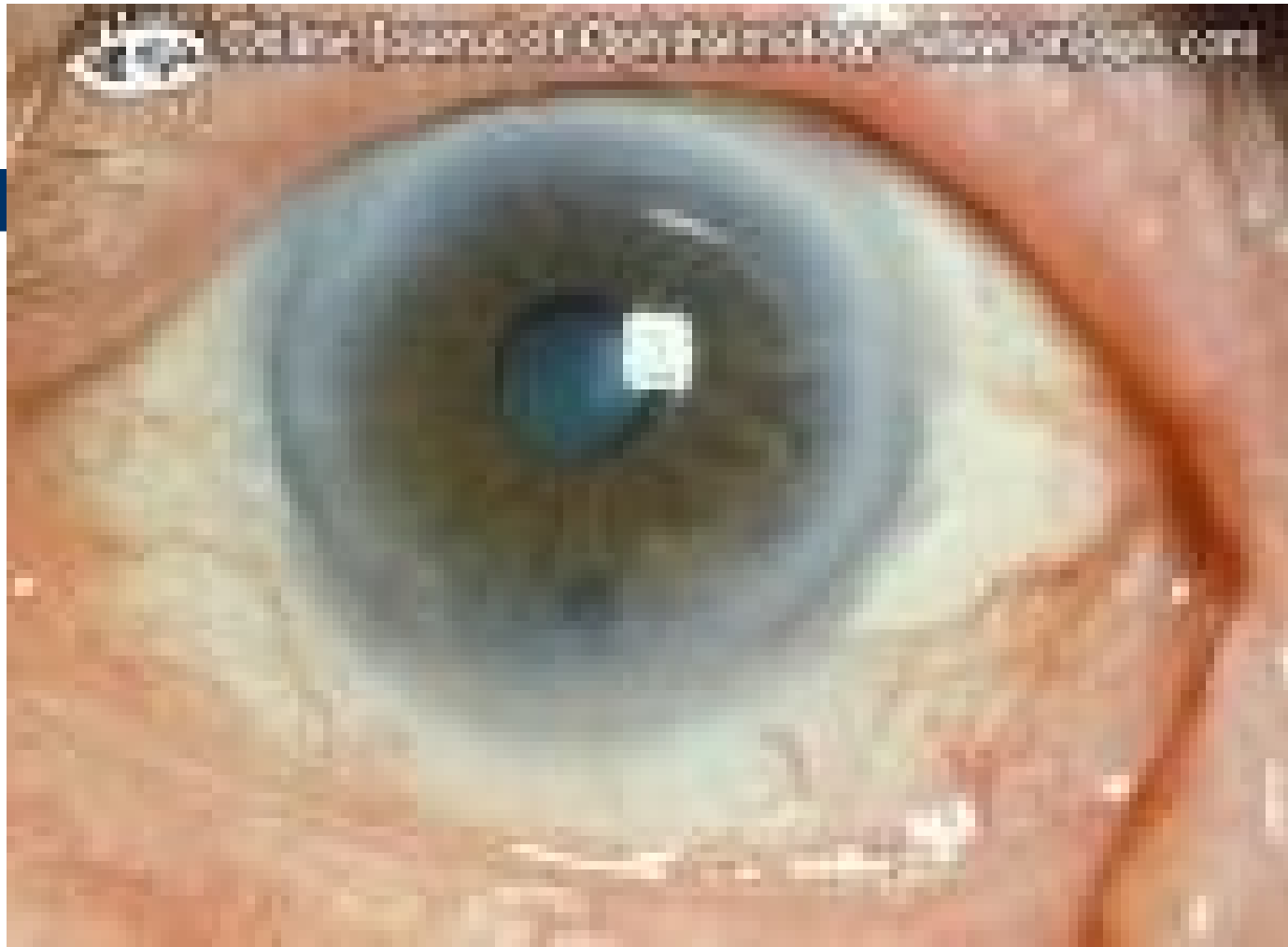
- Thiamine (B1)
- Riboflavin (B2)
- Niacin
- Pyridoxine (B6)
- Cyanocobalamin (B12)
- Ascorbic Acid
- Folic acid

Mineral and trace element deficiencies

- Calcium, Magnesium, Phosphorus
- Iron
- Zinc
- Copper
- Selenium
- Iodine

6 YO female

- Called to peds ward for “midnight special” admission prior to umbilical hernia repair.
- Pt adopted from Korea and only recently arrived in US.
- Pt appears thin and, although awake, appears to have trouble seeing.



Vitamin A deficiency

- Peri-operative implications:
 - Increased susceptibility to infection.
- Gee whiz stuff:
 - First sign night blindness.
 - Xerosis of conjunctiva and cornea → Keratomalacia, ulceration, perforation and cornea scarring → lens prolapse → blindness
 - Follicular hyperkeratosis, pruritis, growth retardation

Perioperative management

- Not much you can do for emergent cases.
- Role in immune function???????
- Vit A is a component of retinal pigments rhodopsin and iodopsin.
- Found in liver, milk fat, egg yolk, green and yellow fruits and vegetables.



sometimes i take a carton
of eggs out of the fridge
and look at it and think
that maybe one day i'll
crack an egg and a
little baby chicken will
fall out, and i'll wash
him off and raise him
indoors

and then... then i'll have
a friend

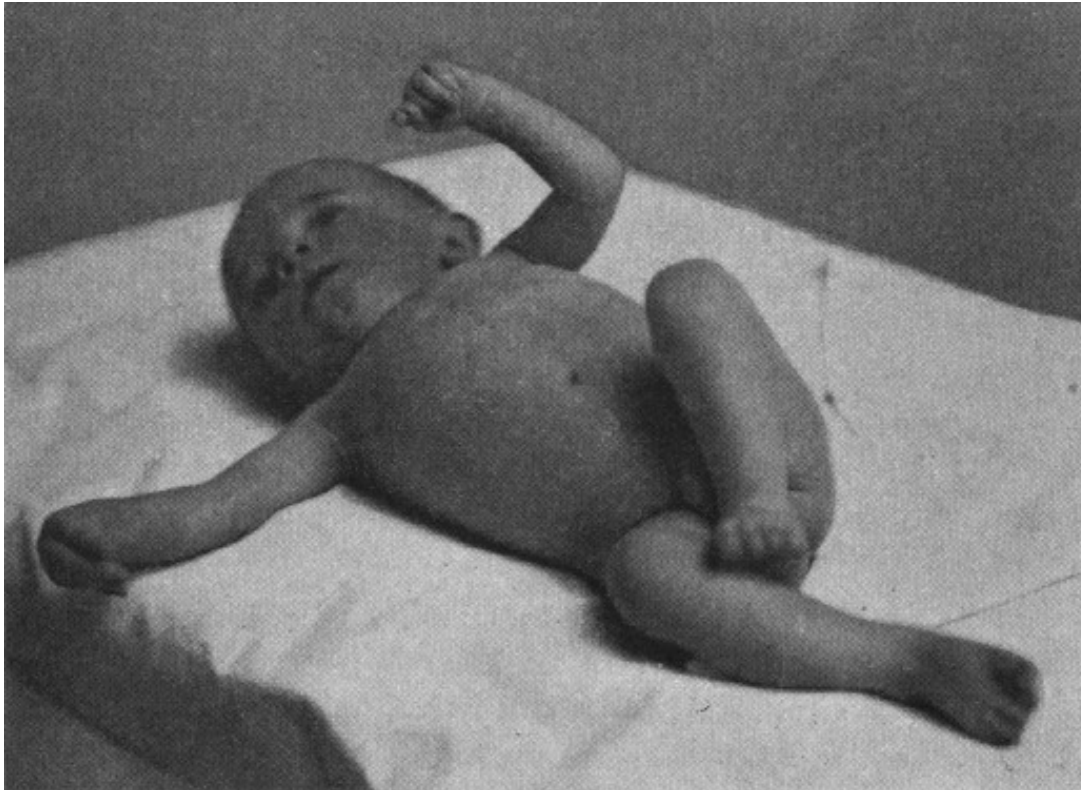
6 month old male

- Children's hospital. Umbilical hernia repair.
- Child only breast fed.
- Mom is Islamic and states that she is allergic to milk.
- Baby has funny looking chest.
- On positioning for intubation, your fingers cause a depression in the skull – somewhat like a dent in a ping pong ball.

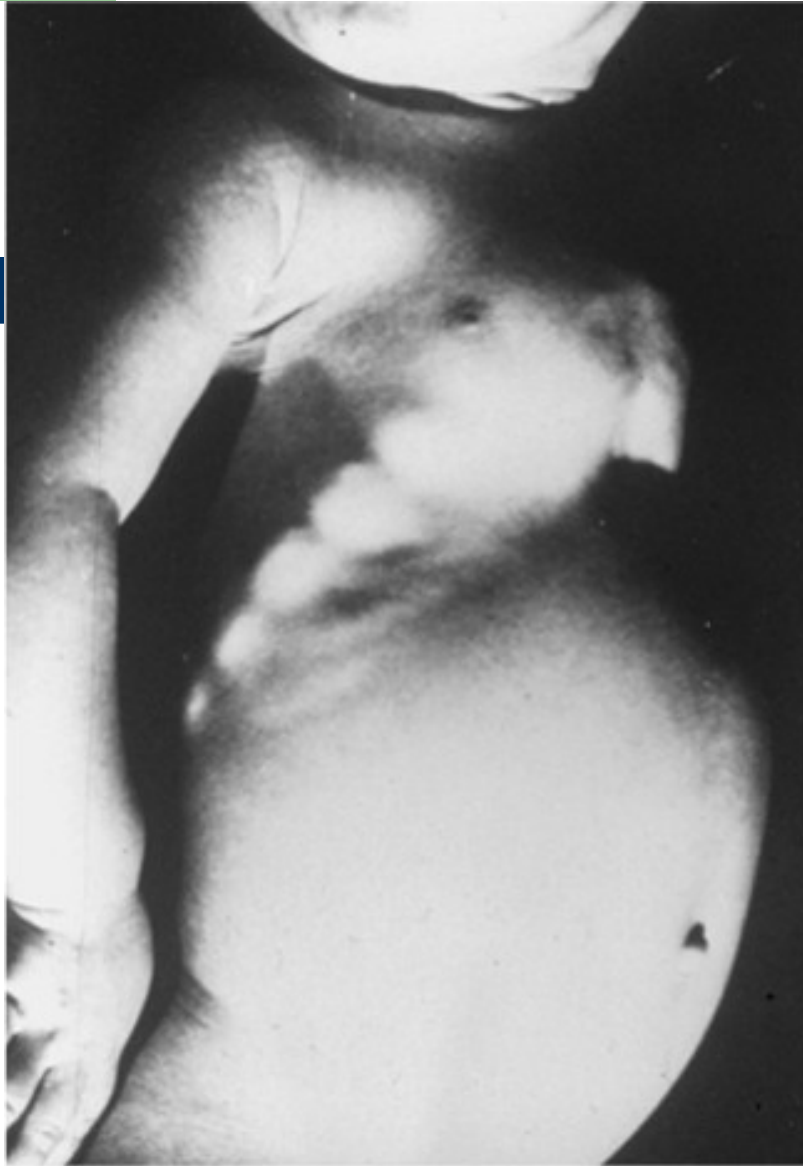
Vitamin D

- Peri-operative implications:
 - Hypocalcemia, Hypophosphatemia
 - Craniotabes
 - Beading of the ribs (rachitic rosary)
 - Scoliosis
- Gee whiz stuff:
 - Rickets, osteomalacia, large anterior fontanelle, frontal bossing of skull, delayed teeth, exaggerated lordosis, bowlegs, greenstick fx

Spasmophilia. Infant in state of "tetany."









Perioperative management

- Education of parent.
- Vitamin supplementation
- Ca, phos level check

15 YO male for appy

- Pt has cystic fibrosis. On chronic antibiotics.
- Stopped taking multivitamin because it tastes gross.
- On starting IV you note bleeding around IV site.
- Pt states gums bleed at times when brushing his teeth.

Vitamin K deficiency

- Peri-operative implications:
 - Increased bleeding: Vit K necessary for formation of prothrombin, proconvertin, plasma thromboplastin component, and Stuart-Prower factor (II,VII,IX,X) as well as protein C+S (anticoagulants) and Z+M (stimulate platelets)

Perioperative management

- Check PT, PTT
- Pt should receive Vit K and FFP prior to surgery with goal of normal coags.
- Vit K is fat soluble. Decreased serum concentrations occur with decreased fat absorption, Abx, diarrhea

2 YO female for T&A

- Only eats chicken nuggets and scrambled eggs. Drinks only sprite.
- Won't let you do a good airway/mouth exam.
- Mask induction. When scissoring mouth open, all teeth feel loose and wobbly. Bleeding gums noted.

Million dollar question.

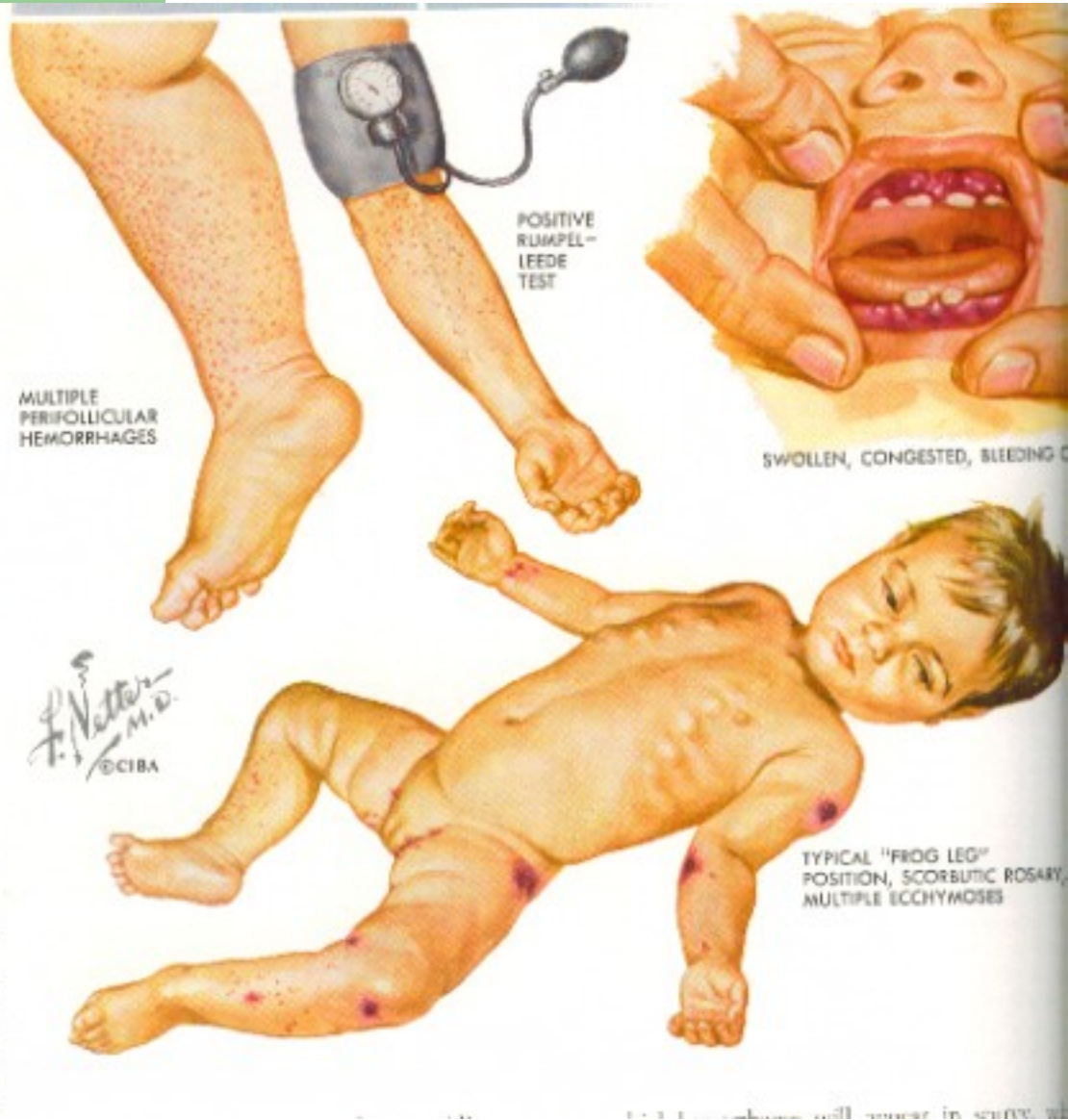
- What do humans (and other primates) and guinea pigs (and 1 species of bird and 1 species of bat) have in common?
- They can't synthesize vitamin C

Vitamin C

- Peri-operative implications:
 - Impaired wound healing
 - Loosening of the teeth
 - Severe may lead to cardiac hypertrophy, bone marrow depression, adrenal atrophy.
- Gee whiz stuff:
 - Defective dentin
 - Brittle bony trabeculae.
 - Subperiosteal hemorrhage
 - Petechial hemorrhages in skin and mucous membranes

More vit C info

- Vit C works in multiple enzyme systems.
- Major role is in formation of normal collagen



30-ish male struck by car

- Pt disheveled appearing on arrival per report (broken bottle of hooch found in pocket)
- Thin, pale appearing, mild peripheral edema, hypotensive, tachycardia.
- X-lap performed and splenic lac repaired.
- Glucose found to be 60 - D50 given
- Pt given multiple units of crystalloid, prbcs

30ish guy continued

- Despite only 500 ml EBL from abd, no other bleeding source and large fluid resuscitation, pt's hypotension worsens.
- CVP 19.
- EKG – low voltage QRS, prolonged QT
- 3rd heart sound and apical systolic murmur noted.

Thiamine (B1) deficiency

- Peri-operative implications:
 - High output heart failure
 - Tachycardia
- Gee whiz stuff:
 - Also associated with Beriberi, fatigue, irritability, anorexia, constipation, headache, insomnia, polyneuritis, edema, elevated pyruvic acid
 - Liver, meat (esp pork), milk, whole grain, legumes, nuts.

- “The metabolically active form of thiamin, called thiamin pyrophosphate (TPP), is critical in the intermediary metabolism of carbohydrate. TPP is involved in three enzyme systems: (1) pyruvate dehydrogenase, which converts pyruvate to acetyl coenzyme A; (2) α -ketoglutarate dehydrogenase, which catalyzes the conversion of α -ketoglutarate to succinate in the Krebs cycle; and (3) transketolase, which catalyzes the pentose monophosphate shunt”



i hate you
forever dad



the one bad thing
about naming your
son "banjo"

Perioperative management

- If suspected deficiency → treat with “banana bag”
 - NS, MVI, 100 mg thiamine, 1 mg folate, Vit B12

48 YO female for knee replacement.

- Hx of Crohn's Disease s/p ileal resection x2.
- Uncomplicated 3 hour surgery using Iso-N2O for maintenance.
- In days that followed pt developed paresthesias in all limbs.
- Over next few weeks sx's worsened and pt found to have subacute combined degeneration of the spinal cord.
- Pt treated but had permanent motor weakness and paresthesias in all limbs.

Vitamin B12 deficiency

- Peri-operative implications:
 - Use of Nitrous Oxide in patients with vitamin B12 deficiency associated with neurologic degeneration.
 - B12 essential for maintenance of myelin sheath. N2O associated with rapid progression of degeneration.
- Multiple case reports of transient to permanent neurologic deficits (and some deaths) following N2O
- Megaloblastic anemia

Perioperative management

- Give vitamin B12 to patients with confirmed/suspected deficiency.
- Avoid N2O in high risk patients (Pts without ileum, intrinsic factor deficiency, strict vegetarians or vegans)

FUN FACT:
fish can't smell

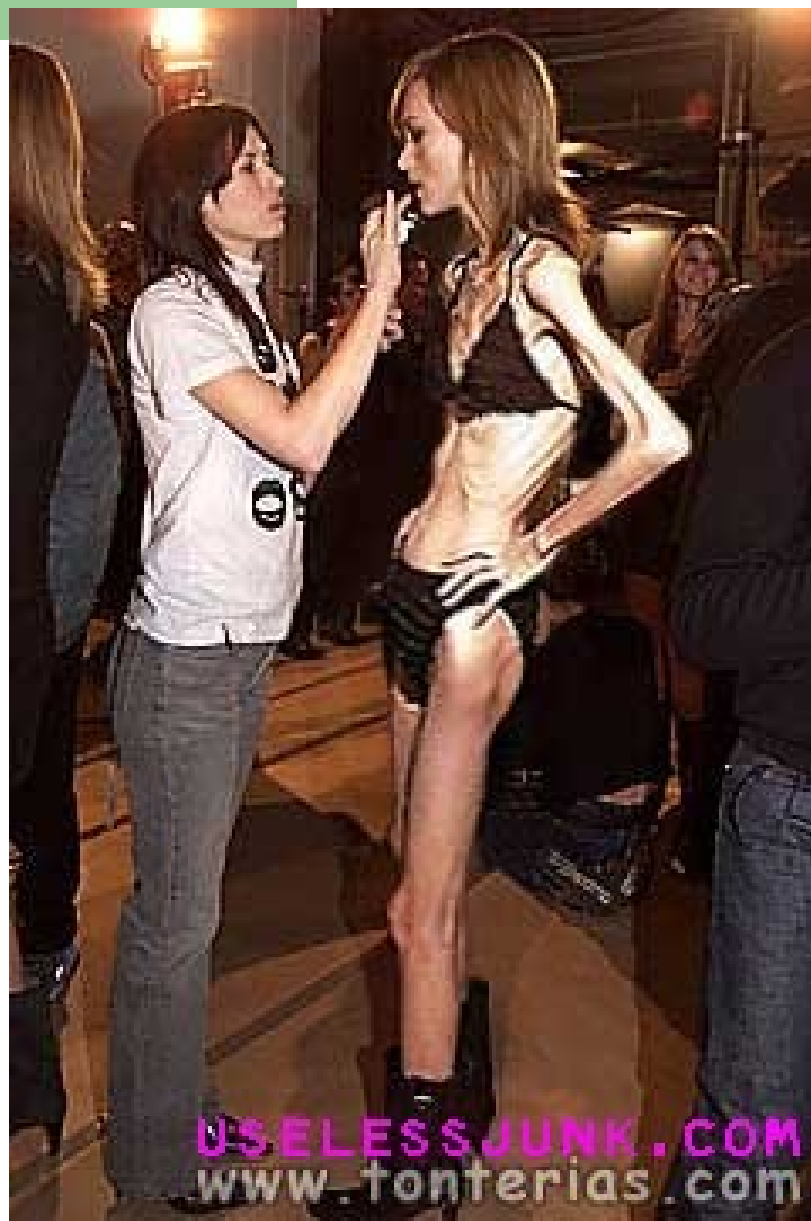
i haven't
showered in
days



it's cool,
i can't
smell

26 YO female “model” for appy.

- BMI 14 (165 cm, 38 kg).
- 2 hour procedure. 2 L LR given.
- Pt to PACU uneventfully.
- 5 hrs after arriving on ward, unresponsive.
- Glucose immeasurable.
- Despite tx and return to normal glucose levels, pt suffered irreversible brain damage.



Severe Malnutrition

- Peri-operative implications:
 - Along with other vitamin and mineral deficiencies mentioned. May be more prone to episodes of hypoglycemia.
- Glycogen → 24 hours of glucose
- Other sources: Glycerol, lactate, pyruvate, AA (esp. alanine)
- Fatty acids → ketone bodies

Perioperative management

- If malnutrition is suspected, check glucose levels prior to surgery and frequently thereafter.
- Note that post-op hypoglycemia severe enough to cause permanent brain damage is very rare.

Club foot repair in 3 YO female adopted from China.

- Child is very thin.
- Mask induction followed by vecuronium for NMB
- 3 min after vec administered, intubation leads to much gagging and bucking.
- During the case the child seems to be going through twice as much vec as anticipated.
- Reversal uncomplicated

Effect of Vec in undernourished children.

- Peri-operative implications:
 - Study evaluated 4 groups of children: normal nutrition, mild, moderate, and severe malnourished.
 - Time to 25% NM depression: 0.8, 1.4, 1.3, 2.1 min
 - Duration of action: 26.5, 24, 17.7, 13.3 min

Severe malnutrition

- Respiratory muscle weakness
- Decreased metabolic rate, hypoxic response, and hypercapnic response

Same little girl as above

- Towards end of case – EKG changes are noted. Pt with some rales post extubation. CXR shows cardiomyopathy (dilated on subsequent echo).
- Troponin levels elevated

Selenium Deficiency

- Peri-operative implications:
 - Dilated cardiomyopathy
 - Myocardial necrosis and fibrosis
- Gee whiz stuff:
 - Also muscle pain, myopathy, loss of hair pigment, and nail bed changes.
 - Called Keshan disease and occurs primarily in rural China tykes. Rare in US – long term home parenteral nutrition.

5 YO M, broken femur (closed) from fall

- Pt very pale.
- Despite min EBL, pt tachycardic, hypotensive, and is desaturating despite appropriate fluid management.
- CBC shows Hct 18 with microcytic hypochromic picture.

Iron deficiency

- Peri-operative implications:
 - Anemia (microcytic, hypochromic)
 - Severe may present with lethargy, pallor, irritability, cardiomegaly, tachypnea, impaired development.
- Gee whiz stuff:
 - May get a hx of pagophagia

Perioperative management

- Ensure adequate Hct
- Lower threshold for transfusion
- Responds rapidly to treatment with iron

Mg

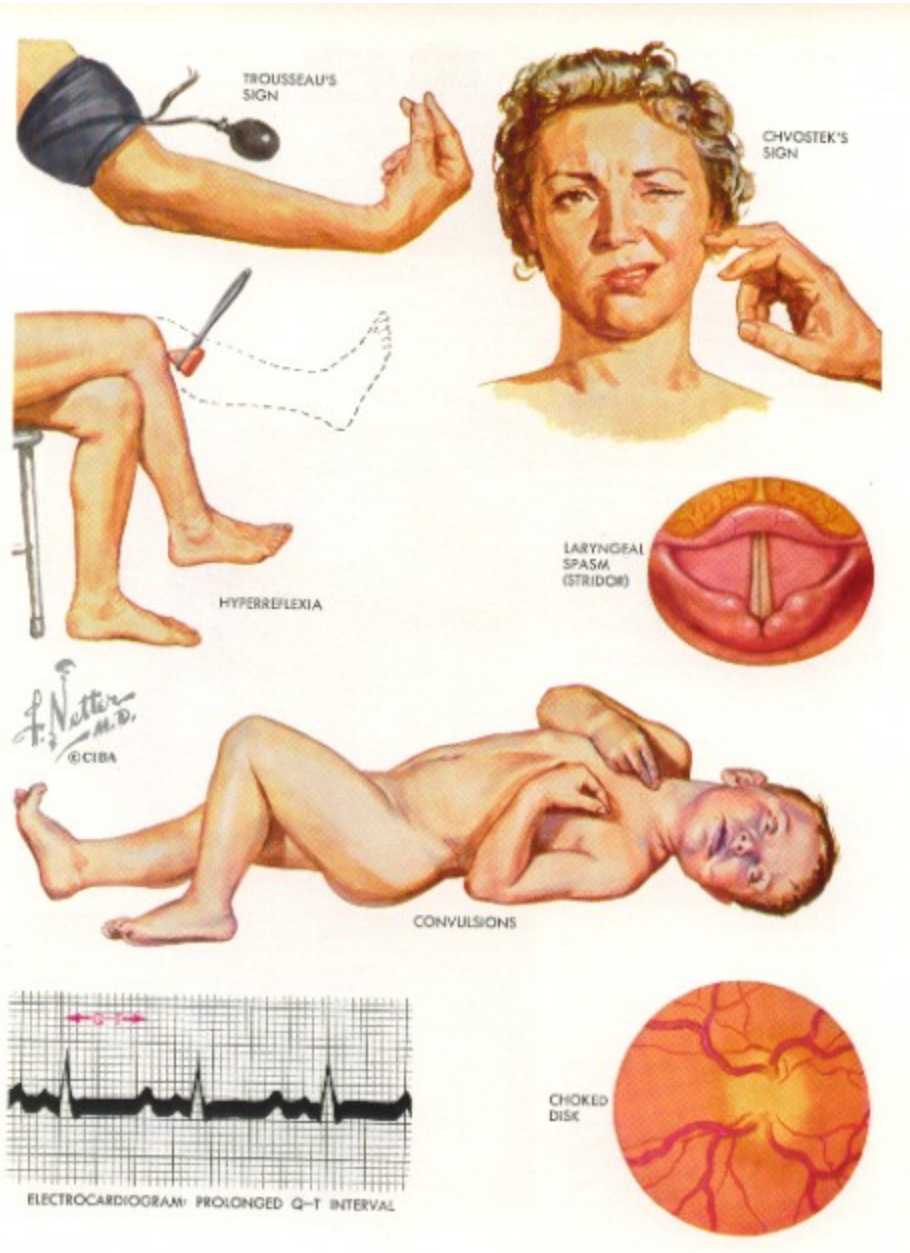
- Hypomagnesemia - lowers threshold for epinephrine induced arrhythmias. Typically associated with hypoCa, hypoK and manifests with muscle fasciculations, tremors/spasms, personality change, and seizures.

Ca

- From a nutritional standpoint – usually in conjunction with VitD or parathyroid.
- Tetany, Chvostek, Trousseau, seizures.

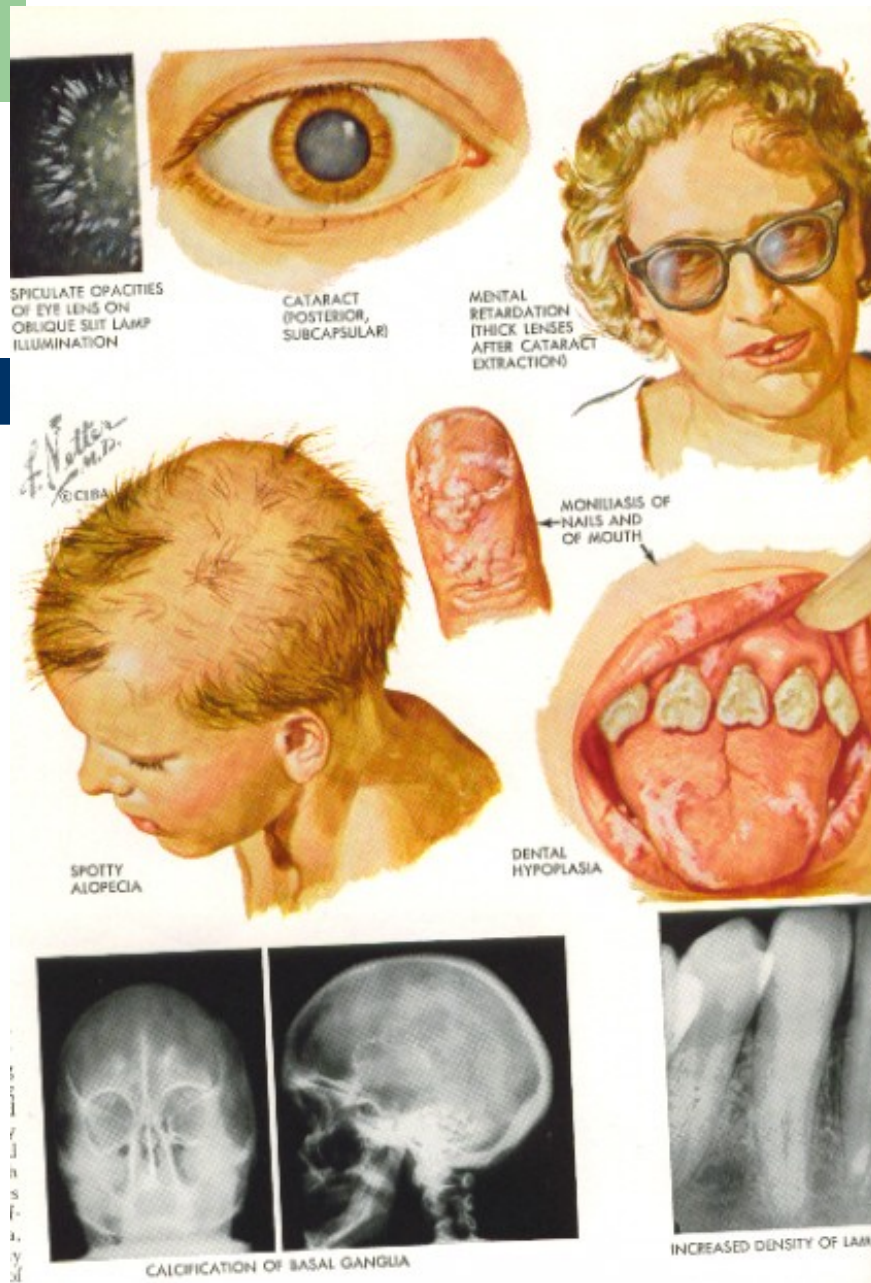
HypoCa

- Acute



HypoCa

- Chronic





every time you hear
a cell phone ring, an
angel gets kinda
annoyed

Others (minimally-anesthetic effecting)

- Pyridoxine (B6): Hypochromic anemia, convulsions, irritability, peripheral neuritis in pts taking isoniazid, oxaluria.
- Folicin: Megaloblastic anemia, impaired immunity, glossitis, pharyngeal ulcers

Others (minimally-anesthetic effecting)

- Zinc: Increased susceptibility to infection, poor appetite, alopecia, dermatitis, poor growth.
- Copper: Sideroblastic anemia, neutropenia, failure to thrive, skeletal abnormalities
- Hypophosphatemia: Acute areflexic paralysis with respiratory failure. Also can cause myopathy, rhabdomyolysis, bone pain, osteomalacia.



GARDENING TIP:

if your dog has the habit of trampling or eating your vegetable plants, grind him up and sprinkle him on the garden at a ratio of $\frac{1}{4}$ cup dog to 1 gallon water. he will be an excellent source of nitrogen and phosphorus for your growing plants.

**Others (non-anesthetic
effecting)**



Bigfoot's garage sale



nah, there's nothing
much here, just some
rudimentary tools and
some bloody shreds of
clothing

Others (non-anesthetic effecting)

- Vit E: Present in leafy greens, nuts, legumes, seed oils. Needs bile for absorption. Can cause RBC hemolysis in premies and loss of neural integrity.
- Riboflavin (B2): Angular stomatitis, glossitis, seborrheic dermatitis, cornea vascularization.
- Niacin (B3): Pellagra (dermatitis, diarrhea, dementia, weakness)

How I remembered Niacin deficiency

- When you're sick with the runs and you're too weak to run – that's Pellagra
- When your skin starts to itch and your eye starts to twitch – that's Pellagra
- Take your Niacin – in meats, and greens, and grains, in vegetables it's in – No Pellagra.
- NAD, NADP, coenzymes I&II will thank you – No Pellagra



sometimes i listen /
to a rock band /
in my room /
i am very sad

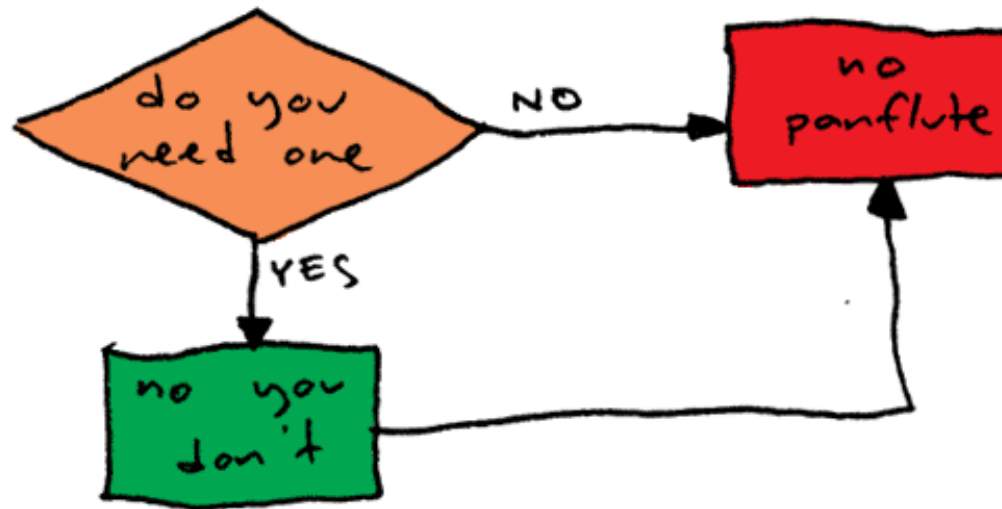
bad poetry? oh noetry!

Others (non-anesthetic effecting)

- Iodine – MR if deficient early. Hypotonia, macroglossia, hoarseness, growth retardation, and constipation.

Malnutrition flowchart

PANFLUTE FLOWCHART



Conclusion (...finally!)

Any Questions?????



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